To: Regional Engineers

From: Jim Goddard

Subject: IB Joints – Watertight Joints

The problem with making an IB joint that will consistently pass a hydrostatic pressure test is much more complex than many seem to understand, at least as represented in our discussion on Thursday in Salt Lake City. The problem issues include production tolerances, resin shrinkage, and the PE response to tensile stresses. Based on what we all should have learned about PE response to stress from the professors during the week, I offer the following comments:

1. The force on the bell is tension when tested under pressure. The tension can be calculated based on the following calculation:

   Tensile Stress = (pressure x diameter x Pi /2) / Thickness

2. The tensile strain can be approximated based on the materials properties we discussed in Utah:

   Modulus of Elasticity = Tensile stress / tensile strain

   Therefore:

   Tensile strain = Tensile stress / Modulus of elasticity

But what values do we use in this equation for a viscoelastic material such as polyethylene? We can start with an initial set of values based on the cell classification required in AASHTO. This is conservative, but it does give us a good place to start. In this case E is 110,000 psi and tensile strength is 3,000 psi. If the stress is at this level the resultant strain is 2.72% initially. But, if the time required in the test is considered, 10 minutes, the effective E is a time effective value, about 30% less than the 110,000 psi value, or 77,000 psi. At this modulus value the strain under the same stress is 3.8%. For a 24" diameter pipe this is an increase in circumference of 3.28"! It is an increase in diameter of 1". Such a strain could lead to eventual stress

cracking. This is an extreme case, but it should make a point; a point you must translate to sales.

Attached is a table of the relevant values needed to do these calculations. Also attached is a curve representing the expansion of a 36" rotomolded bell in a test conducted on with a bell wall thickness of 0.350". The IB bell (Ultra) has a typical wall thickness of 0.210". It is reasonable to assume the expansion of the IB bell would be at least 67% greater, or 0.5" in diameter at 10 psi.

While it is true that the production variations in dimensions create additional potential joint performance problems, the fundamental issues are the thickness of the bells and the relaxation rate of the material. This is primarily an engineering issue and not a quality issue as indicated by some individuals at the Regional Engineers' meeting.

Larger, stiffer gaskets, while providing a short-term solution, may only aggravate the problem by placing additional tensile stress on the bell, leading to additional creep and possible cracking.

We have discussed additional things that might be done to limit or prevent the relaxation of the bells. We have nothing at the moment to offer to solve this problem.

It should be of note that in the sanitary sewer market, where the in-lab/in-plant pipe joint test requires 10.8 psi for 10 minutes, the in-ground leakage is typically set at 50 to 100 gallons/inch of diameter/mile/day. In short, although the ASTM D 3212 test requires a bottle-tight joint the in-ground test accepts some leakage. If our test pressure and/or time is less than 10.8 psi for 10 minutes it seems reasonable to expect somewhat greater in-ground leakage.

Before there is another discussion like the one on Thursday at the Regional Engineers' meeting, think about the material we are working with and the basic engineering properties of the material and the process limitations of the manufacturing methods.

cc: Joe Chlapaty
Tom King
Bob Slicker
Pat Collings
Bill Shaffer
Kevin Jehl
Mark Arnold

# II. Improved Profile Design

A. AASHTO Efforts

1. The Materials Engineers included the Moser Table of Dimensionless Parameters in the Appendix of M 294 and MP7 ballot. That is due back in now. Hancor has made a concerted effort to have it removed. We will see how the vote turns out.
2. We will begin, immediately, to prepare our recommendations for next year's ballot items. Among the options considered are;
   a. Moving Moser's table into the body of the standard.
   b. Requiring a higher buckling point in the parallel plate test, going from 20% to 30%. Our new designs will meet this consistently. Many in our industry can not meet this with current tooling.
   c. Offering two classes of pipe in M 294, one that passes only 20% and one that passes 30%.
   d. Including the curved beam test in AASHTO with a maximum thinning of the wall section at springline.
   e. Complete all of the recommendations prior to April 1 and have them in the hands of the AASHTO SOM 4b members. Work closely with Cecil Jones (NCDOT) and Bill Bailey (VaDOT) to see that this gets done in a manner acceptable to them.
   f. Need a decision on how much of this we do with CPPA. Hancor will not like much of this.

B. ADS Efforts:

1. Manufacture & testing of the new Drossbach 48" and 60" designs.
2. Conversion of old style profiles to the newer, more stable design family. This may take some time, but if we fix the poorest ones first we should be in very good shape.
3. One of the profile problems is the new companies who will come into this business in the future. Most have no concept about profile design and are simply focused on pipe stiffness. How do we reach the equipment manufacturers so they do not provide such poor designs to the industry, such as Quail's designs from Unicor?
4. Continue the close work between Randy Kolbet and Jim Goddard on design issues.

## III. NCLS Test

A. ASTM:

1. The NCLS test is going to main committee ballot with all sub-committee negatives resolved. Vote for passage and continue to work with PPI (Gene Palermo) to get this passed as a standard.
2. Continue to work with the PPI Task Group to get a precision and bias statement completed.
3. Work toward a finished pipe test

B. AASHTO

1. As soon as the ASTM test is approved, move to have it replace the SP-NCTL test in the AASHTO Materials Specifications.
2. Work toward a finished pipe test using NCLS

IV. High Efficiency Stormwater Retention/Recharge System Design

A. Test Installation(s)

1. Salt Lake City Plant installation has been in 4 months with no known problems. It has been inspected internally a couple of times. (Goddard)
2. Article on that installation for publication in a trade magazine is nearly complete and ready to go. (Radoszewski & Goddard)
3. A cost comparison between a conventional layout and the high efficiency design has been prepared (specifically comparing the Salt Lake City design). (Spires) We need to develop a more general comparison that basically develops a template where site specific requirements can be plugged in (Goddard & Spires)
4. Additional installations need to be sold that we can monitor; preferably in different areas of the country. Installations must be monitored by our own people (Regional Engineers) and contractors must follow our guidelines strictly.
5. Introductory information on the design concept, Salt Lake City installation, and testing has been distributed to the Regional Engineers and the Zone Sales Managers for their use in identifying sites and promoting them with the consulting engineers and owners.

B. Patent information has been assembled, but the application has not yet been submitted. (King & Goddard) ***This is a very high priority.***

C. A SWRR literature piece covering standard and the high efficiency designs should be developed. Existing SWRR CD-ROM design procedure needs to be updated to include the new design, (Collings, Spires, & Goddard)

D. This should be placed on our web site as soon as possible (Radoszewski, Collings, Spires, & Goddard)

E. Comparisons in design and cost should be prepared for this design versus CSP and chamber designs. (Goddard & Spires)

F. A system installation guide explaining system installation from start to finish must be prepared ***quickly*** and completely and be available to consultants and contractors.

G. Engineering should meet with the target zones to help get this started.

H. Sales should begin approaching firms that build a number of buildings around the country to promote this design (Wendy's, McDonalds, Burger King, Target, Home Depot, K-Mart, etc.) using the tools that must be developed above.

## V. Watertight IB

1. The concept for a wrapped IB bell to resist expansion under pressure was first presented to the New Products Committee almost two years ago. Yet we have yet to make one. We have been too damn slow!
2. Patent!! We must get this filed quickly. We may have to prove when we began work on the concept. ***This is a very high priority!!***
3. The first sizes we manufacture should be 30", 36" and 24". These will have the greatest financial impact. This requires modifying the IB bells to maximize performance and appearance. 18" down should follow as quickly as practical.
4. Testing should begin as soon as samples are available. Test to 10.8 psi per ASTM D 3212 and test to higher limits to failure. (My guess is we might fail the pipe before the joint.)
5. Offer for sale first on the West Coast, then expand east as markets require.
6. See current proposed time-line.

# VI. Profile Stability Issue – AASHTO (adjunct to Item II)

A. Specification Options and Approaches
   1. Increase deflection requirement prior to buckling to 30%.
   2. Offer two classes of pipe in M 294, 20% buckling limit and 30% buckling limit.
   3. Add the Curved Beam Test (Goddard/Gabriel) to AASHTO standards with a limit of wall thinning at springline of <10% at 10% chord shortening of a 90 degree wall section.
   4. Expand the Dimensionless parameter table to include other items that need to be included. Look closely at shape factors. Move into the body of the standard.

B. National Transportation Research Board
   1. Session 294 on Tuesday night at TRB was put together by me to present 5 different approaches to this issue, 4 of which I support.
   2. Ohio University will present four papers on their deep burial study at two TRB sessions on Wednesday. Try to tie wall stability into the findings. 42" Drossbach pipe is included.

C. ADS Efforts
   1. Prepare a paper for submission to ASCE or similar venue that pulls all of the wall profile approaches into one document; with recommendations based on those approaches and field (test) verification. The tests are already largely done except for a few more curved beam tests to be completed at Sacramento State University. This is a minimum cost item, but will take time and is badly needed. (Goddard & Collings)

## VII. Corporate Engineering

We are being much less effective than we should or could be because we are understaffed. We (Pat Collings, Bob Slicker, Bill Shaffer, Greg Spires, and Jim Goddard) are spending too much time "fire-fighting" and things are not getting done in a timely fashion. Other items are just falling through the cracks and simply not getting done. This working group is actually smaller in number than it was in the mid 1980s, while the company has grown up around us. The work load has increased substantially. The impact of errors (of omission or commission) is much larger, financially and physically. One of the things we have historically done well is maintain good personal relationships with key DOT engineers, and that is becoming more difficult. The growth of our industry has led to increased competition and increased competitive focus and our ability to respond in a timely fashion has not kept up. Committee responsibilities (ASTM for Slicker, ASTM, ASSHTO, & TRB for Goddard) are also demanding more time; but to be effective, that is what is needed. Based on all of that, two people should be added, one with some experience and one fresh from engineering school.

Also, it is in the company's best interest to be looking at people to succeed those in place now. What damage would be done if one of the people in this department were lost through accident or job change?